The University of Chicago

INTELLIGENCE AND BIRTH ORDER IN FAMILY

A DISSERTATION SUBMITTED TO THE
GRADUATE FACULTY IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

By
MINNIE LOUISE STECKEL

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INTELLIGENCE AND BIRTH ORDER IN FAMILY*

From the Psychological Laboratories of the University of Chicago

MINNIE LOUISE STECKEL

STATEMENT OF THE PROBLEM

The object of this study was to discover, if possible, any relationship which might exist between intelligence of children and their birth order.

A parallel study of the problem was made by L. L. Thurstone, University of Chicago, and Richard L. Jenkins, Illinois Institute for Juvenile Research, based upon the data of the Institute population. The records at the Institute are largely of retarded children of foreign-born parentage. The records of the Stanford-Binet examination were used in the study at the Institute.[1]

The data upon which this study is based were obtained from children enrolled in the public schools at Sioux City, Iowa, during the years, 1926-1928, from Grade 1 to Grade 12, inclusive. During this period tests were given to approximately 20,000 children. Because of the large number of children tested, obviously, it was necessary to use group tests.

The study covers a wide range of intelligence. It was necessary, therefore, to use four different group intelligence tests. The tests used for the various grades were as follows:

Tests	Grades
Kuhlmann-Anderson	Jr. 1 to Jr. 3
National	Sr. 3 to Sr. 4
Otis Intermediate	Jr. 5 to Sr. 8
Otis Advanced	Jr. 9 to Sr. 12

Only the grade in which the child happened to be placed determined which test he would take.

*Received for publication by L. L. Thurstone of the Editorial Board, October 7, 1929.

[1]It was at the suggestion and under the direction of L. L. Thurstone that this study was made along similar lines on a large population of normal children of a more or less typical community. The present study was made in partial fulfillment of the requirements for the Degree of Doctor of Philosophy at the University of Chicago.

The tests were given by the writer and an assistant after a uniform mode of procedure had been established. The scoring of the tests and the tabulation of the results were done by two experienced scoring clerks.

Questionnaires were sent to the parents asking them for the names and ages of all their children, including records of any children who had died. No attempt was made to obtain a record of miscarriages. The questionnaires were sent home by the children and returned in like manner. An effort was made not to associate the test with the questionnaire, although the questionnaires were always sent out two or three days following the testing of the children of any particular school.

The questionnaire data and the test results were recorded for the children of each family. In grouping by families, it was necessary to discard the record of any child on which either the test data or the questionnaire were lacking. Also only the records of those children were retained for which there were data also for a brother or sister up to the eighth-born child. Thus only the data of siblings were used in the present study.

There were data for one or both of approximately 150 pairs of twins. These data, as well as the records of step-siblings, were not included in the study for they would tend to bring in additional variables not included in the regular sibling data.

The intelligence quotients as obtained by each of the tests were translated into their equivalent standard scores. The constant 5.00 was added to these scores to avoid negative values. By using the intelligence quotient upon which to base the calculations rather than the raw score, there is obtained a measure which is uncorrelated with age. The computation of standard scores for each test eliminates the possibility of differences which might arise due to the relative difficulty of the scale at the various age levels.

Table 1 gives the number and sex of children for each birth order.

TABLE 1

NUMBER OF CHILDREN FOR EACH BIRTH ORDER

	1st Born	2nd Born	3rd Born	4th Born	5th Born	6th Born	7th Born	8th Born	Total
Male	838	962	675	412	212	146	90	46	3,381
Female	821	1012	637	378	282	148	86	45	3,409
Total	1659	1974	1312	790	494	294	176	91	6,790

The total number of individual children, 6,790, group themselves into 5,928 pairs of siblings. The total number of families represented is 2,712. These include 1,864 families of which both parents are American-born and 602 families of which both parents are foreign-born. They include also 164 families of which the mothers are American-born but the fathers are foreign-born and 82 families of which the fathers are American-born but the mothers are foreign-born. The study is limited to the Caucasian race. Both sexes are about equally represented. The age range covers from year 5 to year 21. The range of intelligence is from 50 to 165 points *I.Q.*

Sioux City is located on the Missouri River, directly north of Omaha, Nebraska. Its population is estimated at 86,000. There are no slums or tenement districts. There is evidently nothing inherent in the general population which might bias the results of the study.

With so large a sampling, the selection of which was entirely dependent upon the willingness of parents to answer a questionnaire, the fact that it is a sampling of a school population should, when handled statistically, not bias the results.

Analysis of the Data

In Table 2, of which Figure 1 is the graphical representation, are given the mean standard scores for each birth order up to and including eighth-born children.

TABLE 2
Mean Standard Score for Each Birth Order

Birth Order	1	2	3	4	5	6	7	8
Mean standard score	5.1	5.1	5.1	5.1	5.0	4.9	4.8	5.0
Number of children	1659	1974	1312	790	494	294	176	91

This analysis would indicate that there is very little difference between the mean intelligence of the various ordinal groups. The earlier-born children appear to have a slightly higher intelligence. It is, however, a well-known fact that the lower socio-economic classes have larger families and that on the average the children of larger families have lower intelligence quotients. There is, as indicated in Table 2, a preponderance of smaller families. These two

factors, the preponderance of smaller families and the lower intelligence of large families, obscure the correlation we are investigating, i.e., intelligence and ordinal number.

In order to control size of family and the socio-economic factors, the records were paired so that with the record of each first-born child there is compared the record of the second-born sibling; with the record of each second-born child there is compared the record of the third-born sibling, etc., up to the eighth-born children. In this method of comparing ordinal groups, a family is represented equally often in each comparison group and thus the comparison is made between members of the same family. Since in a school population it is possible often to secure records of a child and one sibling but not of other siblings, the records that were available were grouped according to their ordinal number. The mean standard score for each group of each pair was computed and their difference indicated as in Table 3.

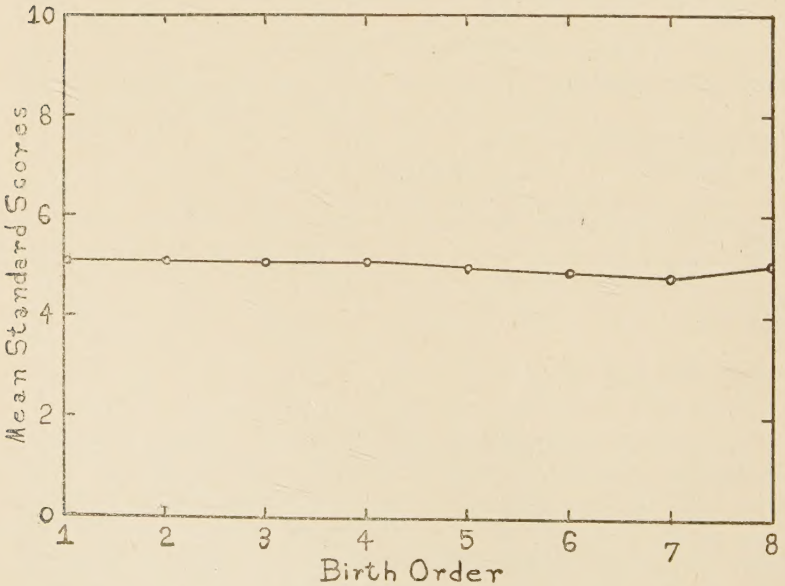

FIGURE 1

MEAN STANDARD SCORES FOR EACH BIRTH ORDER

TABLE 3

DIFFERENCE BETWEEN THE MEAN STANDARD SCORES OF VARIOUS ORDINAL GROUPS

Number of families	M_8	M_7	M_6	M_5	M_4	M_3	M_2	M_1	Difference
1523							5.2877	−5.1869	.1008
665						5.2850		−5.0639	.2211
235					5.3213			−5.0149	.3064
69				5.0986				−4.9174	.1812
24			5.2208					−4.8250	.3958
4		5.0750						−4.7000	.3750
1	5.7000							−4.7000	1.0000
946						5.2185	−5.0652		.1533
376					5.2399		−4.9673		.2726
129				5.0953			−4.8124		.2829
39			5.1359				−4.6487		.4872
9		4.9222					−4.4778		.4444
0	no data						no data		no data
544					5.1669	−4.9877			.1792
201				5.1080		−4.8542			.2538
71			5.0873			−4.5732			.5141
21		5.2238				−4.5333			.6905
5	5.2000					−4.5000			.7000
328				5.0872	−5.0034				.0838
113			5.0717		−4.8814				.1903
44		5.1545			−4.9614				.1931
14	5.1643				−4.7714				.3929
197			4.9690	−4.8320					.1370
85		5.0706		−4.8706					.2000
30	5.1667			−4.8000					.3667
125		5.0000	−4.7840						.2160
51	5.0529		−4.6706						.3823
79	5.0734	−4.9848							.0886

The first column indicates the number of families represented in each ordinal group. The notation, M_8, M_7, M_6, etc., indicates the mean standard score of the ordinal group in the column with that subscript. In the last column are recorded the differences between the mean standard scores of the various ordinal groups, as indicated. The notation is:

$$M_2 - M_1 = d_{21}$$

In which M_2 is the mean standard score of second-born children and M_1 the mean standard score of their first-born siblings; and d_{21} is the difference between the mean standard scores of the two groups indicated, or more generally

$$M_a - M_k = d_{ak}$$

Thus the mean standard score for each possible pairing of ordinal numbers is recorded and their difference indicated.

A very remarkable fact is that in the entire table there are no inversions. All differences are in favor of the group of later-born children. It was thought at first that it might be an artifact due to the manner in which the data had been handled. A careful check does not reveal that such is the case. Since the study is so extensive in scope, the tabulations were made by a Power's automatic sorting machine. The data were punched directly from the printed record cards upon the Power's cards and sorted into ordinal groups and distributions by an experienced Power's machines operator. The handling of the record cards previously was done almost entirely by clerks and by teachers in Sioux City Schools, who at the time were not aware of the fact that the work was for any purpose other than those of the regular plan of any testing program in a public school system.

Table 4 shows the differences between the mean standard scores of the first-born children and the mean standard score of the second-born children, the mean standard score of first-born children and third-born children, the mean standard score of the first-born and fourth-born children, i.e., Table 4 is a summary of the differences between the mean standard scores for all comparison groups up to and including fourth-born children.

TABLE 4

DIFFERENCES IN MEAN STANDARD SCORE FOR THE FIRST FOUR ORDINAL NUMBERS

		Birth Order			
		1	2	3	4
Birth Order	1		.1008	.2211	.3064
	2	—.1008		.1533	.2726
	3	—.2211	—.1533		.1792
	4	—.3064	—.2726	—.1792	

These differences, as indicated in Table 4, are the differences from a direct comparison of 12 ordinal groups. A combination of these differences, so that there are obtained the differences between the mean standard scores for the first-born and second-born, for the second-born and third-born, and for the third-born and fourth-born, is computed in the following manner.

Indicating the direct differences by d, the indirect differences by d', the formula is stated as follows:

$$d_{ak} - d_{bk} = d'_{ab}$$

in which d_{ak} and d_{bk} are the direct differences of the ordinal numbers indicated in the subscripts. The differences are thus calculated between the values in adjacent columns which are summed and the means computed, i.e., $\frac{\Sigma d'_{ab}}{N} = D_{ab}$; in which D_{ab} is the calculated difference between the two ordinal groups in question. For example, the following equations are solved for Columns 1 and 2 of Table 4:

$$\begin{aligned} d_{21} - d_{11} &= d'_{12} \\ d_{22} - d_{12} &= d'_{12} \\ d_{23} - d_{13} &= d'_{12} \\ d_{24} - d_{14} &= d'_{12} \end{aligned}$$

$$\text{then } \frac{\Sigma d'_{12}}{4} = D_{12}$$

By this method there is obtained a very good approximation of the difference between the first-born and second-born if the data were complete for all families. All differences between the four ordinal groups are computed in this manner. There is a duplication in the first two items of each series due to the fact that $d_{11}=0$, $d_{22} = 0$

$$\begin{aligned} \text{then } d_{21} - d_{11} &= d_{12} \\ d_{22} - d_{12} &= d_{12} \end{aligned}$$

These two items have double weight, but, since they amount to direct comparison, this duplication has been considered justifiable.

The differences computed from the values in Table 4 are as follows:

Successive differences	Accumulative differences
1 — 1 = 0	1 — 1 = 0
2 — 1 = .08	2 — 1 = .08
3 — 2 = .13	3 — 1 = .21
4 — 3 = .14	4 — 1 = .35

The accumulative differences are shown in Figure 2.

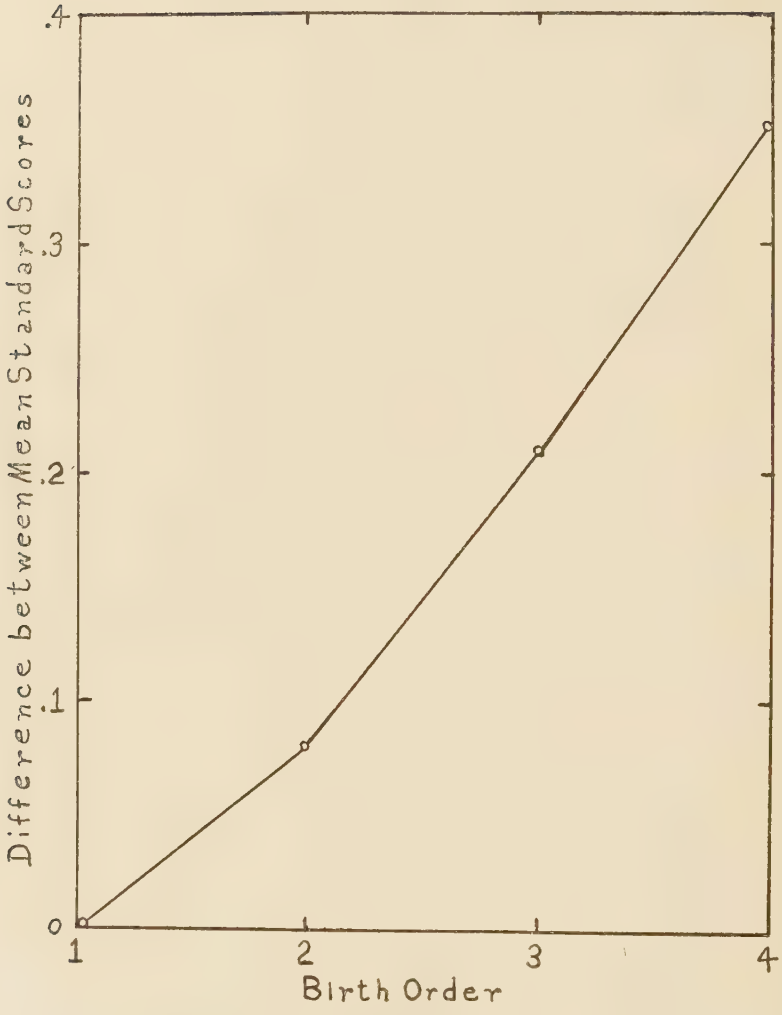

FIGURE 2

DIFFERENCES BETWEEN MEAN STANDARD SCORES, FIRST FOUR ORDINAL NUMBERS

In Table 5 are tabulated the differences for all possible combinations of comparison groups up to and including eighth-born children.

TABLE 5

DIFFERENCES BETWEEN MEAN STANDARD SCORES FOR THE FIRST EIGHT ORDINAL NUMBERS

Birth Order	1	2	3	4	5	6	7	8
1	.0000	.1008	.2211	.3064	.1812	.3958	.3750	1.0000
2	—.1008	.0000	.1533	.2726	.2829	.4872	.4444	no data
3	—.2211	—.1533	.0000	.1792	.2538	.5141	.6905	.7000
4	—.3064	—.2726	—.1792	.0000	.0838	.1903	.1931	.3929
5	—.1812	—.2829	—.2538	—.0838	.0000	.1370	.2000	.3667
6	—.3958	—.4872	—.5141	—.1903	—.1370	.0000	.2160	.3823
7	—.3750	—.4444	—.6905	—.1931	—.2000	—.2160	.0000	.0886
8	—1.0000	no data	—.7000	—.3929	—.3667	—.3823	—.0886	.0000

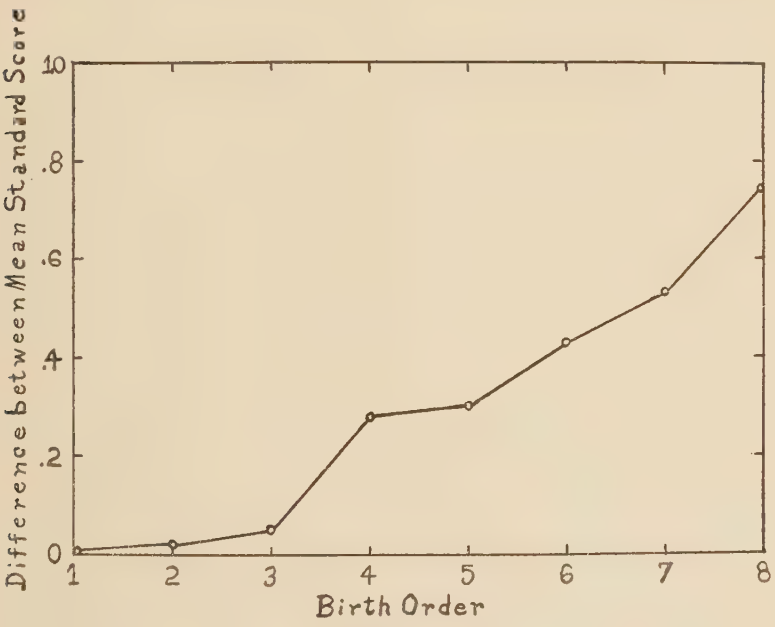

FIGURE 3

DIFFERENCE BETWEEN MEAN STANDARD SCORES, FIRST EIGHT ORDINAL NUMBERS

The same computations were made for these 28 observation equations as were made for the data in Table 4. The results are as follows:

Successive differences	Accumulative differences
$d_1 - d_1 = .000$	$d_1 - d_1 = .000$
$d_2 - d_1 = .006$	$d_2 - d_1 = .006$
$d_3 - d_2 = .039$	$d_3 - d_1 = .045$
$d_4 - d_3 = .233$	$d_4 - d_1 = .278$
$d_5 - d_4 = .025$	$d_5 - d_1 = .303$
$d_6 - d_5 = .129$	$d_6 - d_1 = .432$
$d_7 - d_6 = .113$	$d_7 - d_1 = .545$
$d_8 - d_7 = .192$	$d_8 - d_1 = .737$

The accumulative differences are represented graphically in Figure 3. As the ordinal number increases, the difference between mean standard scores from the first-born steadily increases until the difference between the first-born and eighth-born is .74.

Obviously, there must always be a first-born child in every family of children, and the greater the ordinal number the fewer representatives there will be for that ordinal number. It is impossible, therefore, to obtain as many records for later-born children as for earlier-born children. For the 28 observation equations tabulated in Table 5, the group representation varies from 1,523 families representing the first-born and second-born children to one family representing the first-born and eighth-born children. In the computation of differences between mean standard scores of the various ordinal groups, the differences established by a very small number of families are given equal weight with differences established by a very

TABLE 6

DIFFERENCES BETWEEN MEAN STANDARD SCORES FOR THE FIRST EIGHT ORDINAL NUMBERS: NO ITEM ESTABLISHED BY LESS THAN FIFTY FAMILIES

Birth Order	1	2	3	4	5	6	7	8
1	.0000	.1008	.2211	.3064	.1812			
2	—.1008	.0000	.1533	.2726	.2829			
3	—.2211	—.1533	.0000	.1792	.2538	.5141		
4	—.3064	—.2726	—.1792	.0000	.0838	.1903		
5	—.1812	—.2829	—.2538	—.0838	.0000	.1370	.2000	
6			—.5141	—.1903	—.1370	.0000	.2160	.3823
7					—.2000	—.2160	.0000	.0886
8						—.3823	—.0886	.0000

large number of families. This gives too much weight to the differences established by the smaller groups and too little weight to differences established by the larger groups. The observation equations, therefore, vary in reliability depending on the number of families represented in each.

Table 6 shows only those observation equations which are established by no less than 50 families. When those differences which were established by a very few families are eliminated, the relative differences between the various ordinal groups should be nearer the true value.

The results of this solution are as follows:

Successive differences	Accumulative differences
$d_1 - d_1 = .0$	$d_1 - d_1 = .0$
$d_2 - d_1 = .040$	$d_2 - d_1 = .040$
$d_3 - d_2 = .110$	$d_3 - d_1 = .150$
$d_4 - d_3 = .176$	$d_4 - d_1 = .326$
$d_5 - d_4 = .030$	$d_5 - d_1 = .356$
$d_6 - d_5 = .032$	$d_6 - d_1 = .388$
$d_7 - d_6 = .197$	$d_7 - d_1 = .585$
$d_8 - d_7 = .114$	$d_8 - d_1 = .699$

A comparison of the accumulative differences of this solution with the accumulative differences of the solution in which all 28 observation equations are used, regardless of the number of families by which each observation equation is established, shows that the increment in mean intelligence from the first birth order to each successively higher birth order is increased for the earlier birth orders although the final difference between the first-born and eighth-born is less than in the former solution.

In the next solution, all 28 observation equations have been used, but each equation is weighted according to the number of families for each pair of ordinal numbers. That is, the weight of each observation equation is the number of families it represents. In this solution, from the 28 observation equations tabulated in Table 5, there were derived seven normal equations, and with the mean standard score of the first-born children as an origin, the mean standard score for each of the ordinal groups was calculated by the method of least squares.

The successive differences obtained by this calculation are as follows:

$$M_1 - M_1 = .0$$
$$M_2 - M_1 = .09$$
$$M_3 - M_1 = .23$$
$$M_4 - M_1 = .39$$
$$M_5 - M_1 = .46$$
$$M_6 - M_1 = .58$$
$$M_7 - M_1 = .75$$
$$M_8 - M_1 = .87$$

The object of this solution, in addition to establishing the fact of differences and direction of those differences, is to disclose, if possible, some general law or tendency, independent of accidental variation, which might be operative in the distribution plotted from the observed data. As is shown in Figure 4, it is apparent that the mean intelligence rises with birth order. This increase continues even to the eighth-born children. Whether the intelligence would continue to rise indefinitely with each ordinal number is an interesting speculation. It is conceivable that beyond a certain point the age and exhaustion of the parents might be detrimental influences for the

FIGURE 4

DIFFERENCE BETWEEN MEAN STANDARD SCORES BY METHOD OF LEAST SQUARES

child's inheritance and development. It is not within the scope of this thesis to establish the exact amount of increase from one ordinal group to the next higher, yet it is interesting to note that there is indication that intelligence is directly proportional to birth order.

In order to check somewhat the foregoing solutions and to establish more definitely conclusions which might be drawn from this study, a more direct solution of the problem was made in the following manner. The problem was limited to include only those families for which there were data for the first two, the first three, or the first four children. The number of families that have more than two or three children attending public school at the same time is decidedly limited. Fortunately in the population here represented the data are adequate to include families of as many as four children. For families for which there were data for the first two children, the mean standard score of the first-born children is compared with the mean standard score of the second-born children. For families for which there were data for the first three children, the mean standard scores of the first-born, second-born, and third-born children are compared and, similarly, the mean standard scores of the first-born, second-born, third-born, and fourth-born children are compared in families for which there were data for the first four children. From the results of this solution, as indicated in Table 7 and shown graphically in Figure 5, it is apparent that intelligence increases with birth order, for, although the solution is limited to families of two, three, or four children, as the ordinal number increases the mean standard score also increases. The mean standard score of the 1,523 second-born children is greater than the mean standard score of their 1,523 first-born siblings; the mean standard score of the 542 third-born children is greater than the mean standard score of their 542 second-born siblings, and the mean standard score of these second-born siblings is greater than the mean standard score of their 542 first-born siblings. The same relationship holds between the mean standard scores of the ordinal groups when represented by the first four children of each family.

It is interesting to note that the mean standard score decreases as the number of children representing a family increases. When the comparison is limited to the first two children in a family as indicated by Curve A in Figure 5 the mean standard score for both first-born and second-born children is higher than the mean standard scores for those birth orders when the comparison includes the first three

children of a family as indicated by Curve B. The mean standard scores represented in Curve B, in turn, are greater than the mean standard scores represented by Curve C where the comparison is limited to families represented by the first four children. This indicates a tendency for the more prolific families to possess children of lower intelligence. The same factor seems to be present in the results plotted in Figure 1.

TABLE 7

MEAN STANDARD SCORES FOR EACH BIRTH ORDER

	Number of Families	Birth Order 1	2	3	4
A	1,523	5.187	5.288		
B	542	5.076	5.124	5.267	
C	164	5.023	5.126	5.227	5.401

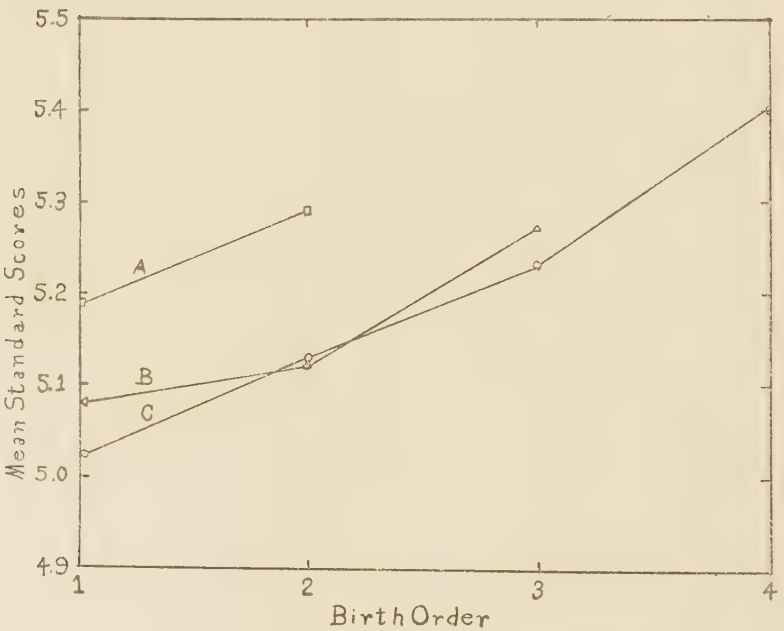

FIGURE 5

MEAN STANDARD SCORES FOR FAMILIES OF TWO, THREE, AND FOUR CHILDREN

	Differences
A	$M_2 - M_1 = .101$
B	$M_2 - M_1 = .048$
	$M_3 - M_1 = .191$
C	$M_2 - M_1 = .103$
	$M_3 - M_1 = .204$
	$M_4 - M_1 = .378$

A comparison of the results of the various methods of solution which have been made to disclose the relationship which might exist between intelligence and birth order shows a remarkable agreement as to the size of the increments in general as well as in the direction of differences in favor of the later-born children.

Conclusion

This study is limited to the disclosing of a general relationship between intelligence and birth order as revealed by a study of a large sampling of normal public-school children of the Caucasian race.

It is not the purpose of this study to establish the amount of increase or decrease which might be expected with each birth order, nor to establish the probability that a child representing any ordinal number will be superior or inferior intellectually to his siblings.

The conclusion drawn from this study applies only to children and their intelligence as related to ordinal number; whether the relationship found holds throughout adult life remains to be revealed by further study.

The writer recognizes that a large number of factors must be taken into account in explaining the differences in intellectual capacity of siblings. This study, however, makes no attempt at a solution or explanation of the cause or causes which might be operative in producing the results which are indicated in the conclusion. Undoubtedly there are both biological and environmental factors involved; what their nature might be or their relative influence is not within the scope of this study.

Although there are indications of many other interesting relationships, such as size of family and intelligence, economic status and intelligence, etc., these are incidental to the main problem: Intelligence and Birth Order in Family.

The conclusion of this study is that on the average later-born children have a higher intelligence quotient than earlier-born children: that in general, intelligence, as measured by intelligence tests, increases fairly uniformly with ordinal number up to and including eighth-born children.

University of Chicago,
Chicago, Illinois

L'INTELLIGENCE ET L'ORDRE DE NAISSANCE DANS LA FAMILLE

(Résumé)

Le but de cette étude a été de découvrir une relation qui pourrait exister entre l'intelligence des enfants et leur ordre de naissance.

L'étude est basée sur les évaluations de l'intelligence de 10,000 élèves des écoles publiques et les données de questionnaires obtenus des parents sur l'ordre de naissance de leurs enfants.

Les quotients d'intelligence obtenus dans chacun de quatre différents tests collectifs d'intelligence ont été traduits en leurs résultats équivalents. On a employé seulement les résultats des enfants de la même famille dans cette étude. Pour contrôler la grandeur de la famille et les facteurs économiques et sociaux on a mis les résultats en paires de sorte qu'on compare aux résultats de chaque premier-né les résultats de son frère ou soeur deuxième-né, aux résultats de ce deuxième-né on compare les résultats de son frère ou soeur troisième-né, etc., jusqu'aux huitièmes-nés y compris.

On présente trois méthodes distinctes de solution du probleme. La comparaison des résultats de ces solutions montrent un accord remarquable dans la grandeur des croissances aussi bien que dans la direction de la différence.

L'étude n'essaie pas d'expliquer les causes qui pourraient aider à produire les résultats. Sans doute elles comprennent les facteurs biologiques et ceux du milieu.

La conclusion de l'étude est qu'en moyenne les premiers-nés n'ont pas un quotient d'intelligence si élevé que celui des enfants de naissance postérieure; qu'en general, l'intelligence, comme mesurée par les tests d'intelligence, s'accroît dans l'ordre de naissance jusqu'aux huitièmes-nés y compris.

STECKEL

INTELLIGENZ UND GEBURTSORDNUNG IN DER FAMILIE

(Referat)

Das Ziel dieser Untersuchung war, Beziehungen zwischen der Intelligenz und der Geburtsordnung aufzudecken.

Die Untersuchung beruht auf Intelligenzprüfungen, die an 10,000 Volksschulkindern vorgenommen wurden, und auf den Antworten eines Fragebogens, die man von den Eltern der Kinder bezüglich der Geburtsordnung erhalten konnte.

Man übersetzte die Intelligenzquotienten, die man mittels vier verschiedener Gruppenintelligenzteste erhielt, in ihre entsprechenden Normalquotienten. Man berücksichtigte nur Angaben über Kinder mit Geschwistern. Um die Grösse der Familie und socialökonomische Faktoren zu berücksichtigen, wurden die Angaben so gepaart, dass das Erstgeborne mit dem Zweitgebornen der Familie, und das Zweitgeborne mit dem Drittgeborenen, usw. bis und mit dem Achtgeborenen verglichen wurde.

In der vorliegenden Arbeit werden drei verschiedene Methoden für die Lösung des Problems dargestellt. Ein Vergleich dieser Ergebnisse zeigen eine auffällige Übereinstimmung hinsichtlich der Zuwachsbeträge als auch der Richtungsunterschiede.

Die Untersuchung macht keinen Versuch die Ursachen zu erklären, die die Ergebnisse hervorgerufen haben mögen. Unzweifelhaft sind Faktoren biologischer Natur und des Milieus beteiligt.

Die Untersuchung führt zur Schlussfolgerung, dass im Allgemeinen spätergeborne Kinder höhere Intelligenzquotienten haben als frühergeborne; dass die durch Intelligenzteste ermittelte Intelligenz mit der Ordnungszahl bis und mit dem achtgeborenen Kinde zunimmt.

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